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BUREAU OF HOME ECONOMICS.

UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1213

Washington, D. C. ▼ February 28, 1924

DIGESTIBILITY OF RAW STARCHES AND CARBOHYDRATES.

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The digestibility of over 100 different food materials has been tested in this department by feeding experiments with normal men.[1] Throughout the work a uniform method has been followed, so that the results obtained with the different materials are directly comparable. It has been commonly assumed that the coefficients of digestibility determined in such experiments with men as subjects are equally applicable in the case of normal women and children, but nothing has been found in the literature to indicate that this has been proved experimentally.

The first four of the eight series of experiments here reported were planned primarily to test this point. Previous experiments with men had shown that raw corn, wheat, and rice starches were completely assimilated without noteworthy physiological disturbance. Raw potato starch, however, taken in the same quantity as the other starches was not completely digested, and the subjects experienced discomfort while on the experimental diet. When raw potato starch was eaten in smaller quantities the coefficient of digestibility was higher. This work was accordingly repeated with practically no change save that women instead of men served as subjects. In two other series of the present experiments the materials used, raw patent and raw graham flour, though not in exactly the same form as in previous experiments with men, were sufficiently similar to indicate relative digestibility with normal men and women.

The main purpose of the present experiments with raw flours was not, however, to show whether or not sex affected the digestibility,

[1] U. S. Dept. Agr. Buls. 310 (1915), 470 (1916), 505 (1917), 507 (1917), 525 (1917), 612 (1917), 613 (1919), 630 (1918), 649 (1918), 687 (1918), 717 (1918), 751 (1919), 781 (1919), 1033 (1922). Jour. Agr. Research 6 (1916), No. 16, p. 577–588; 6 (1916), No. 17, p. 641–648. Jour. Biol. Chem. 41 (1920), No. 2, p. 227–235; 42 (1920), No. 1, p. 27–40; 52 (1922), No. 1, p. 251–261. Jour. Ind. & Eng. Chem. 12 (1920), No. 10, p. 975. Amer. Jour. Physiol. 54 (1921), No. 3, p. 479–488. Jour. Home Econ. 15 (1923), No. 12, p. 699–701.

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but rather to supplement the existing information as to the digestion of raw starches. The previous work had been done with separated starches, but there were no similar data regarding the digestibility of raw flours and meals; accordingly the present experiments included the wheat flours already referred to and also farina and white corn meal.

When these experiments were being carried on there chanced to be available a supply of the little-known Chinese type of maize known as waxy maize. The endosperm of this grain is characterized not by starch but by a substance that, like some dextrins, gives the red color reaction with iodin. As little is known regarding this substance, waxy maize was included among the materials tested in the present experiments.

EXPERIMENTAL METHOD.

Each special product under investigation was eaten as a constituent of a frozen pudding of which it made up about 20 per cent. The pudding, made according to the formula used in previous similar experiments, was flavored with vanilla and resembled ice cream in taste and texture.

EXPERIMENTAL FROZEN PUDDING.

6 quarts of milk.	2½ cups sugar.
4 pounds raw starch, or cereal product.	1 tablespoon salt.
3 cups table oil.	½ cup vanilla extract.

The uncooked starch or cereal product was mixed with the milk, sugar, and oil, and immediately frozen in the same way as ice cream.

The puddings made with raw cornstarch and raw corn meal were not agreeable to the taste, but all of those made with wheat products, and especially those made of farina and graham flour, were considered agreeable by the subjects.

The cereal products used were examined by G. L. Keenan of the microchemical laboratory, Bureau of Chemistry, and proved to be free from foreign matter. It had been shown in previous work that, so far as could be determined, wetting and immediate freezing did not affect the starch grains in such puddings.

The subjects were business or professional women who were conscientious and trustworthy. Three of them served in practically all the experiments and other suitable women were added for one or more experiments.

The subjects all seemed in normal health and for the most part remained so throughout the experiments. The notes that they regularly kept of their unusual sensations indicate occasional headaches, general depression, or similar discomfort. Such symptoms are not referred to in connection with the individual experiments because they can hardly be attributed to the raw starch itself. Similar discomfort has frequently been noted when persons change from a normal to a limited diet or vice versa, and the large proportion of very cold food in the present experimental meals might in itself be sufficient explanation. Moreover, other persons employed in the same building as some of the subjects experienced similar discomfort, which they attributed to the very hot weather and to an odor of fresh paint throughout the building.

The experimental period for a diet was three days and included nine meals. Between experiments came an interval of three or four

days in which the ordinary diet was followed. The foods were attractive in appearance, and the table was neatly set with white covers and dishes. The subjects were given weighed portions of the frozen pudding along with a weighed ration of oranges and sugar, and tea or coffee as desired. In a preliminary experiment it was found that subjects were able to eat 300 grams of frozen pudding at a meal, and accordingly this quantity was usually weighed out for each person. If any of the weighed portions was not eaten, the residue was weighed and careful account was kept of the amount eaten by each subject.

The quantity of raw starch usually eaten per woman per day was about 170 grams, or a little over a pound in three days. This quantity of raw starch quite closely approximates that eaten by the subjects in the experiments with men. The quantity of oranges consumed was limited to that consumed by the men. The quantity of sugar used in beverages was within limits left to the discretion of each subject and varied from none at all to 100 grams per woman daily. In determining the coefficients of digestibility of starch alone, corrections were made for undigested sugar. The quantity of sugar consumed did not seem to affect the digestibility of the starch as so determined.

The feces belonging to an experimental diet were marked by carmine taken with the first meal and were separated from the feces of the subsequent regular diet by lampblack taken with the first regular meal. It was noticed that the carmine colored the feces for two or three days after it was taken. The drying and analysis of foods and feces and the correction for metabolic products were all made according to methods used in the experiments with men.

It was noticed in mixing the materials to make the frozen pudding that the raw cornstarch did not blend well with the oil and milk, and this made it difficult to obtain uniform samples for moisture and fat determinations of the cornstarch pudding. The other pure starches mixed better with the oil and milk, and the flours, farina, and corn meal mixed well with the oil, so that in these puddings the samples obtained were uniform and the moisture and fat determinations agreed closely in the five samples taken of each pudding. The ability of the flours and starches to mix well with the oil and milk as contrasted with the poor mixture obtained with the cornstarch can probably be explained by difference in surface attraction of the raw materials for the oil.

In order to determine the coefficient of digestibility of the carbohydrate of patent flour, graham flour, farina, and corn meal, an analysis was made of these substances and the amount of carbohydrate to be attributed to each in a given diet was calculated from the amount of the substance known to have been eaten in the frozen pudding.

Microscopic examinations of the feces were made by one of the authors in the microchemical laboratory of the Bureau of Chemistry to discover whether or not they contained undigested grains of raw starch.

The nitrogen determinations were made in the nitrogen laboratory and the fibre determinations in the food-control laboratory of the Bureau of Chemistry. Determinations not otherwise specified were made in the laboratory of the Bureau of Home Economics.

EXPERIMENTS WITH RAW CORNSTARCH.

Four experiments were conducted with raw cornstarch. The diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 22 grams; fat, 52 grams; carbohydrate, 341 grams; energy, 1,920 calories. The average amount of raw cornstarch eaten per woman per day was 174 grams.

TABLE 1.—*Digestion experiments with raw cornstarch in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1174, subject G. B.:						
Frozen pudding (raw cornstarch, 529.3 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,750.0	*Grams.* 1,653.3	*Grams.* 59.1	*Grams.* 208.2	*Grams.* 811.5	*Grams.* 17.9
Fruit	990.0	860.3	7.9	2.0	114.8	5.0
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,740.0	2,513.6	67.0	210.2	926.3	22.9
Feces	35.0	.....	9.3	8.7	9.9	7.1
Amount utilized	.....	.....	57.7	201.5	916.4	15.8
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	86.1	95.9	98.9	69.0
Estimated digestibility of raw cornstarch alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1197, subject A. T. M.:						
Frozen pudding (raw cornstarch, 517.9 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,697.5	*Grams.* 57.0	*Grams.* 135.8	*Grams.* 794.1	*Grams.* 15.7
Fruit	1,022.0	888.1	8.2	2.0	118.6	5.1
Sugar	277.0	.....	.....	.....	277.0	.....
Total food consumed	3,999.0	2,585.6	65.2	137.8	1,189.7	20.8
Feces	36.0	.....	11.7	8.3	10.4	5.6
Amount utilized	.....	.....	53.5	129.5	1,179.3	15.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	82.1	94.0	99.1	73.1
Estimated digestibility of raw cornstarch alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1198, subject C. M.:						
Frozen pudding (raw cornstarch, 517.9 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,697.5	*Grams.* 57.0	*Grams.* 135.8	*Grams.* 794.1	*Grams.* 15.7
Fruit	1,023.0	889.0	8.2	2.0	118.7	5.1
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,723.0	2,586.5	65.2	137.8	912.8	20.8
Feces	25.0	.....	7.3	5.0	8.8	3.9
Amount utilized	.....	.....	57.9	132.8	904.0	16.9
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	88.8	96.4	99.0	81.3
Estimated digestibility of raw cornstarch alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1199, subject R. L. P.:						
Frozen pudding (raw cornstarch, 517.9 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,697.5	*Grams.* 57.0	*Grams.* 135.8	*Grams.* 794.1	*Grams.* 15.7
Fruit	1,035.0	899.4	8.3	2.1	120.1	5.2
Sugar	150.0	.....	.....	.....	150.0	.....
Total food consumed	3,885.0	2,596.9	65.3	137.9	1,064.2	20.9
Feces	23.0	.....	7.0	6.5	6.4	3.2
Amount utilized	.....	.....	58.3	131.4	1,057.8	17.7
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	89.3	95.3	99.4	84.7
Estimated digestibility of raw cornstarch alone	.....	.....	.....	.....	100.0	.....
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,278.9	856.9	21.9	52.0	341.1	7.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration	.....	.....	86.6	95.4	99.1	77.0
Average digestibility of raw cornstarch alone	.....	.....	.....	.....	100.0	.....

The coefficient of digestibility of the raw cornstarch, corrected for the undigested residue from the accessory foods, was found in each case to be 100 per cent. This was confirmed by the microscopic examination of the feces which showed no starch present. The average coefficients of digestibility for the protein and the fat of the entire ration were found to be 87 per cent and 95 per cent, respectively. The subjects were in normal health during these experiments and found that the diet quite satisfied the appetite.

EXPERIMENTS WITH RAW WHEAT STARCH.

Three experiments were made with raw wheat starch. The diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 21 grams; fat, 64 grams; carbohydrate, 291 grams; energy, 1,825 calories. The average amount of raw wheat starch eaten per woman per day was 168 grams.

The coefficient of digestibility of the raw wheat starch, corrected for accessory food residue, was 100 per cent, and the completeness of digestion of the raw starch was confirmed by the microscopical examination of the feces which showed no starch present. The average coefficient of digestibility of the protein of the entire ration was 79 per cent and that of the fat 94 per cent. A sample of urine from one subject obtained during this diet was found free from sugar or albumin.

TABLE 2.—*Digestion experiments with raw wheat starch in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1175, subject A. T. M.:						
Frozen pudding (raw wheat starch, 504.0 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,725.0	*Grams.* 1,690.0	*Grams.* 55.6	*Grams.* 190.8	*Grams.* 772.8	*Grams.* 15.8
Fruit	881.0	765.6	7.0	1.8	102.2	4.4
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,606.0	2,455.6	62.6	192.6	875.0	20.2
Feces	48.0	.....	13.4	14.9	10.3	9.4
Amount utilized	.....	.....	49.2	177.7	864.7	10.8
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	78.6	92.3	98.8	53.5
Estimated digestibility of raw wheat starch alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1176, subject C. M.:						
Frozen pudding (raw wheat starch, 499.8 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,702.0	*Grams.* 1,675.8	*Grams.* 55.1	*Grams.* 189.1	*Grams.* 766.3	*Grams.* 15.7
Fruit	832.0	723.0	6.7	1.7	96.5	4.2
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,534.0	2,398.8	61.8	190.8	862.8	19.9
Feces	41.0	.....	13.0	11.1	11.2	5.7
Amount utilized	.....	.....	48.8	179.7	851.6	14.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	79.0	94.2	98.7	71.4
Estimated digestibility of raw wheat starch alone	.....	.....	.....	.....	100.0	.....

TABLE 2.—*Digestion experiments with raw wheat starch in a simple mixed diet*—Contd.

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1178, subject R. B.:						
Frozen pudding (raw wheat starch, 504.0 grams or 65.22 per cent of total carbohydrate)	*Grams.* 2,725.0	*Grams.* 1,690.0	*Grams.* 55.6	*Grams.* 190.8	*Grams.* 772.8	*Grams.* 15.8
Fruit	927.0	805.6	7.4	1.9	107.5	4.6
Sugar						
Total food consumed	3,652.0	2,495.6	63.0	192.7	880.3	20.4
Feces	42.0		12.5	11.3	10.0	8.2
Amount utilized			50.5	181.4	870.3	12.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			80.2	94.1	98.9	59.8
Estimated digestibility of raw wheat starch alone					100.0	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,199.1	816.7	20.8	64.0	290.9	6.7
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration			79.3	93.5	98.8	61.6
Average digestibility of raw wheat starch alone					100.0	

EXPERIMENTS WITH RAW RICE STARCH.

Two experiments were conducted with raw rice starch. This diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 22 grams; fat, 44 grams; carbohydrate, 298 grams; energy, 1,675 calories. The average amount of raw starch eaten per woman per day was 169 grams.

TABLE 3.—*Digestion experiments with raw rice starch in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1179, subject A. T. M.:						
Frozen pudding (raw rice starch, 507.3 grams, or 65.22 per cent, of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,721.3	*Grams.* 57.2	*Grams.* 129.1	*Grams.* 777.9	*Grams.* 14.6
Fruit	939.0	816.0	7.5	1.9	108.9	4.7
Sugar						
Total food consumed	3,639.0	2,537.3	64.7	131.0	886.8	19.3
Feces	44.0		13.1	9.7	13.0	8.2
Amount utilized			51.6	121.3	873.8	11.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			79.8	92.6	98.5	57.5
Estimated digestibility of raw rice starch alone					100.0	
Experiment No. 1182, subject R. J.:						
Frozen pudding (raw rice starch, 507.3 grams, or 65.22 per cent, of carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,721.3	*Grams.* 57.2	*Grams.* 129.1	*Grams.* 777.9	*Grams.* 14.6
Fruit	1,011.0	878.6	8.1	2.0	117.3	5.1
Sugar	3.0				3.0	
Total food consumed	3,714.0	2,599.9	65.3	131.1	898.2	19.7
Feces	41.0		11.7	11.8	11.3	6.2
Amount utilized			53.6	119.3	886.9	13.5
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			82.1	91.0	98.7	68.5
Estimated digestibility of raw rice starch alone					100.0	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,225.5	856.2	21.7	43.7	297.5	6.5
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration			81.0	91.8	98.6	63.0
Average digestibility of raw rice starch alone					100.0	

The coefficient of digestibility of the raw starch was 100 per cent for both subjects, and this was confirmed by microchemical examinations of the feces, which showed absence of any starch. The average coefficient of digestibility of the protein of the whole diet was 81 per cent and of the fat 92 per cent.

EXPERIMENTS WITH RAW POTATO STARCH.

In the experiments with raw potato starch the frozen pudding was made up with half the quantity of starch used in the other experiments of this series. This was done with the idea of avoiding the unpleasant physiological effects experienced by the men when they ate large quantities of raw potato starch. In these experiments with women, therefore, the diet furnished the following average quantities of nutrients and energy per woman per day: Protein, 20 grams; fat, 37 grams; carbohydrates, 230 grams; energy, 1,330 calories. The average amount of raw potato starch eaten per woman per day was 68 grams.

The coefficient of digestibility of raw potato starch when corrected for accessory food residue was 100 per cent for subject A. T. M.; for R. L. P. it was 95 per cent; while for C. M., it was 79 per cent; and for E. M., only 49 per cent. These coefficients of digestibility vary in reverse order to the dry weights of the feces and to the proportion of carbohydrate in the dry feces; the latter figures were 48 per cent, 43 per cent, 66 per cent, and 71 per cent, respectively, that is, highest in the experiments in which the coefficient of digestibility was lowest. None of the subjects experienced any physiological discomfort during the experiments and all remained in excellent health. Subject E. M., who digested the raw potato starch least completely, had not been a subject on any previous raw-starch diet, and it is not unlikely that she would have digested the starch more completely in a second experiment.

The average coefficient of digestibility of the protein of the entire diet was 64.6 per cent and that of the fat, 91.9 per cent. The low figure for protein seems to indicate that the digestibility of the protein was decreased when the digestibility of the raw potato starch was low, but since the amount of protein eaten was small the errors involved in the calculation of the protein coefficient are proportionately large and no definite conclusion can be drawn. Microscopic examination showed considerable starch present in all the feces. These results are generally similar to those obtained in experiments with men eating raw potato starch. In the latter over 99 per cent of the potato starch was digested when only 40 grams of starch was eaten per man per day, and about 94 per cent when 70 grams of starch was eaten per man per day. Among the men, as among the women, individuals differed in their ability to assimilate raw potato starch; microscopic examination of the feces also showed undigested starch.

TABLE 4.—*Digestion experiments with raw potato starch in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1200, subject A. T. M.:						
Frozen pudding (raw potato starch, 211.7 grams or 47.4 per cent of total carbohydrate)	*Grams.* 2,000.0	*Grams.* 1,381.0	*Grams.* 50.6	*Grams.* 111.2	*Grams.* 446.6	*Grams.* 10.6
Fruit	1,186.0	1,030.6	9.5	2.4	137.6	5.9
Sugar	285.0	.....	.....	.....	285.0	.....
Total food consumed	3,471.0	2,411.6	60.1	113.6	869.2	16.5
Feces	44.0	.....	12.4	6.2	21.0	4.4
Amount utilized	.....	.....	47.7	107.4	848.2	12.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	79.4	94.5	97.6	73.3
Estimated digestibility of raw potato starch alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1201, subject C. M.:						
Frozen pudding (raw potato starch, 206.4 grams or 47.4 per cent of total carbohydrate)	*Grams.* 1,950.0	*Grams.* 1,346.5	*Grams.* 49.3	*Grams.* 108.4	*Grams.* 435.4	*Grams.* 10.3
Fruit	1,209.0	1,050.6	9.7	2.4	140.2	6.0
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,159.0	2,397.1	59.0	110.8	575.6	16.3
Feces	93.0	.....	17.6	7.9	61.2	6.3
Amount utilized	.....	.....	41.4	102.9	514.4	10.0
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	70.2	92.9	89.4	61.3
Estimated digestibility of raw potato starch alone	.....	.....	.....	.....	79.4	.....
Experiment No. 1202, subject R. L. P.:						
Frozen pudding (raw potato starch, 190.5 grams or 47.4 per cent of total carbohydrate)	*Grams.* 1,800.0	*Grams.* 1,242.9	*Grams.* 45.5	*Grams.* 100.1	*Grams.* 401.9	*Grams.* 9.5
Fruit	1,148.0	997.6	9.2	2.3	133.2	5.7
Sugar	169.0	.....	.....	.....	169.0	.....
Total food consumed	3,117.0	2,240.5	54.7	102.4	704.1	15.2
Feces	72.0	.....	23.4	10.3	31.3	7.0
Amount utilized	.....	.....	31.3	92.1	672.8	8.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	57.2	89.9	95.6	53.9
Estimated digestibility of raw potato starch alone	.....	.....	.....	.....	94.5	.....
Experiment No. 1203, subject E. M.:						
Frozen pudding (raw potato starch, 211.7 grams or 47.4 per cent of total carbohydrate)	*Grams.* 2,000.0	*Grams.* 1,381.0	*Grams.* 50.6	*Grams.* 111.2	*Grams.* 446.6	*Grams.* 10.6
Fruit	1,153.0	1,002.0	9.2	2.3	133.7	5.8
Sugar	26.0	.....	.....	.....	26.0	.....
Total food consumed	3,179.0	2,383.0	59.8	113.5	606.3	16.4
Feces	177.0	.....	28.9	11.1	126.2	10.8
Amount utilized	.....	.....	30.9	102.4	480.1	5.6
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	51.7	90.2	79.2	34.1
Estimated digestibility of raw potato starch alone	.....	.....	.....	.....	49.2	.....
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food comsumed per subject per day	1,077.2	786.0	19.5	36.7	229.6	5.4
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration	.....	.....	64.6	91.9	90.5	55.7
Average digestibility of raw potato starch alone	.....	.....	.....	.....	80.8	.....

EXPERIMENTS WITH RAW PATENT FLOUR.

Three experiments were conducted with raw patent flour made up in the form of frozen pudding, the proportion of flour used being the same as in the case of pure starches. An analysis of the patent flour showed 11.07 per cent water; 12.75 per cent protein; 0.90 per cent fat; 74.84 per cent carbohydrate, including 0.14 per cent crude fiber; and 0.44 per cent ash.

The entire diet furnished the following average quantities of nutrients and energy per woman per day: Protein, 44 grams; fat, 85 grams; carbohydrate, 279 grams; energy, 2,060 calories. The average amount of raw flour eaten per woman per day was 181 grams and the average amount of the carbohydrate due to raw flour eaten per woman per day was 136 grams.

The coefficient of digestibility of the carbohydrate due to raw patent flour alone was 100 per cent in every case. The microscopic examination showed absence of starch grains in the feces and confirmed the chemical determination. The coefficient for the protein of the entire diet was 88.9 per cent; that of the fat, 93.5 per cent.

It is of interest here to note that the average coefficient of digestibility of the carbohydrates in patent flour baked in bread, as determined in previous experiments with man,[2] was 99.7 per cent.

TABLE 5.—*Digestion experiments with raw patent flour in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1183, subject A. T. M.:						
Frozen pudding (carbohydrates of raw patent flour 407.1 grams or 61.19 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,639.7	*Grams.* 122.9	*Grams.* 254.3	*Grams.* 665.3	*Grams.* 17.8
Fruit	1,010.0	877.7	8.1	2.0	117.2	5.1
Sugar						
Total food consumed	3,710.0	2,517.4	131.0	256.3	782.5	22.9
Feces	65.0		23.1	17.2	14.1	10.6
Amount utilized			107.9	239.1	768.4	12.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			82.4	93.3	98.2	53.7
Estimated digestibility of carbohydrates of raw patent flour alone					100.0	
Experiment No. 1184, subject C. M.:						
Frozen pudding (carbohydrates of raw patent flour, 407.1 grams or 61.19 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,639.7	*Grams.* 122.9	*Grams.* 254.3	*Grams.* 665.3	*Grams.* 17.8
Fruit	963.0	836.8	7.7	1.9	111.7	4.8
Sugar	20.0				20.0	
Total food consumed	3,683.0	2,476.5	130.6	256.2	797.0	22.6
Feces	31.0		8.6	8.8	9.3	4.3
Amount utilized			122.0	247.4	787.7	18.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			93.4	96.6	98.8	81.0
Estimated digestibility of carbohydrates of raw patent flour alone					100.0	
Experiment No. 1185, subject R. L. P.:						
Frozen pudding (carbohydrates of raw patent flour, 407.1 grams or 61.19 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,639.7	*Grams.* 122.9	*Grams.* 254.3	*Grams.* 665.3	*Grams.* 17.8
Fruit	995.0	864.7	8.0	2.0	115.4	5.0
Sugar	154.0				154.0	
Total food consumed	3,849.0	2,504.4	130.9	256.3	934.7	22.8
Feces	35.0		12.3	8.4	9.7	4.6
Amount utilized			118.6	247.9	925.0	18.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			90.8	90.6	99.0	79.8
Estimated digestibility of carbohydrates of raw patent flour alone					100.0	
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,249.1	833.1	43.6	85.4	279.4	7.6
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration			88.9	93.5	98.7	71.5
Average digestibility of carbohydrates of raw patent flour alone					100.0	

[2] Proc. Nat. Acad. Sci. 7 (1921), No. 4, pp. 119–123.

EXPERIMENTS WITH RAW GRAHAM FLOUR.

Three experiments were conducted with raw graham flour made up in the form of frozen pudding, the proportion of flour used being the same as in the case of the pure cereal starches. The graham flour was found by analysis to contain 11.82 per cent water; 10.63 per cent protein; 1.71 per cent fat; 74.12 per cent carbohydrate, including 2.25 per cent crude fiber; and 1.72 per cent ash.

The entire diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 40 grams; fat, 83 grams; carbohydrate, 295 grams; energy, 2,085 calories. The average amount of raw graham flour eaten per woman per day was 196 grams and the average amount of carbohydrate supplied by the flour alone was 145 grams per woman per day.

TABLE 6.—*Digestion experiments with raw graham flour in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1194, subject A. T. M.:						
Frozen pudding (carbohydrates of raw graham flour, 462.6 grams or 60.96 per cent of total carbohydrate)	*Grams.* 2,900.0	*Grams.* 1,733.6	*Grams.* 120.1	*Grams.* 262.2	*Grams.* 758.9	*Grams.* 25.2
Fruit	887.0	770.8	7.1	1.8	102.9	4.4
Sugar	122.0	.....	.....	.....	122.0	.....
Total food consumed	3,909.0	2,504.4	127.2	264.0	983.8	29.6
Feces	80.0	.....	18.0	13.9	35.1	13.0
Amount utilized	.....	.....	109.2	250.1	948.7	16.6
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	85.9	94.7	96.4	56.1
Estimated digestibility of carbohydrates of raw graham flour alone	.....	.....	.....	.....	96.4	.....
Experiment No. 1195, subject C. M.:						
Frozen pudding (carbohydrates of raw graham flour, 446.7 grams or 60.96 per cent of total carbohydrate)	*Grams.* 2,800.0	*Grams.* 1,673.8	*Grams.* 115.9	*Grams.* 253.1	*Grams.* 732.8	*Grams.* 24.4
Fruit	817.0	710.0	6.5	1.6	94.8	4.1
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,617.0	2,383.8	122.4	254.7	827.6	28.5
Feces	56.0	.....	13.0	8.4	27.1	7.6
Amount utilized	.....	.....	109.4	246.3	800.5	20.9
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	89.4	96.7	96.7	73.3
Estimated digestibility of carbohydrates of raw graham flour alone	.....	.....	.....	.....	97.3	.....
Experiment No. 1196, subject, R. L. P.:						
Frozen pudding (carbohydrates of raw graham flour, 398.9 grams or 60.96 per cent of total carbohydrate)	*Grams.* 2,500.0	*Grams.* 1,494.5	*Grams.* 103.5	*Grams.* 226.0	*Grams.* 654.3	*Grams.* 21.8
Fruit	754.0	655.2	6.0	1.5	87.5	3.8
Sugar	102.0	.....	.....	.....	102.0	.....
Total food consumed	3,356.0	2,149.7	109.5	227.5	843.8	25.6
Feces	53.0	.....	13.2	9.1	23.4	7.3
Amount utilized	.....	.....	96.3	218.4	820.4	18.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	87.9	96.0	97.2	71.5
Estimated digestibility of carbohydrates of raw graham flour alone	.....	.....	.....	.....	98.0	.....
Average food consumed per subject per day	*Grams.* 1,209.1	*Grams.* 782.0	*Grams.* 39.9	*Grams.* 82.9	*Grams.* 295.0	*Grams.* 9.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration	.....	.....	87.7	95.8	96.8	67.0
Average digestibility of carbohydrates of raw graham flour alone	.....	.....	.....	.....	97.2	.....

The average coefficient of digestibility for the carbohydrate of the graham flour alone was 97 per cent, the lowest single coefficient being 96 per cent. If Prausnitz's figure [3] of 53 per cent is adopted as the coefficient of digestibility for bran, and allowance is made for 47 per cent undigested crude fiber in determining the coefficient of digestibility of carbohydrate from graham flour, the average coefficient becomes 98.7 per cent. Examination of the feces by microscope revealed occasional granules of undigested starch. The coefficients of digestibility of the protein and fat of the entire ration were 87.7 per cent and 95.8 per cent, respectively.

Previous experiments with men in which finely milled graham flour [4] was eaten in the form of bread showed an average coefficient of digestibility of 97 per cent for the carbohydrate of the flour, which is the average coefficient found for raw graham flour in the present experiments with women. This seems to confirm the belief derived from the studies with separate raw starches that sex has no effect on normal digestibility and also indicates that the coefficients of digestibility for either cooked or uncooked graham flour are the same. The undigested carbohydrate is in both cases probably due to bran.

EXPERIMENTS WITH RAW FARINA.

Four experiments were conducted with raw farina. Analysis showed the composition of the farina used to be as follows: Moisture, 11.37 per cent; protein, 13.03 per cent; fat, 0.77 per cent; carbohydrate, 74.27 per cent, including crude fiber, 0.28 per cent; and ash, 0.56 per cent.

The entire diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 45 grams; fat, 74 grams; carbohydrate, 276 grams; energy, 1,950 calories. The amount of raw farina eaten per woman per day was 190 grams and the amount of carbohydrate supplied by the farina was 141 grams.

The average coefficient of digestibility for the carbohydrate of the farina alone was 100 per cent, the lowest single figure being 99.8 per cent. Microscopic examinations did not show the presence of starch in the feces. The coefficients of digestibility of the protein and fat of the entire ration were 92.8 per cent and 96.3 per cent, respectively. The frozen pudding made with farina was particularly well relished by the subjects.

TABLE 7.—*Digestion experiments with raw farina in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1190, subject, A. T. M.:						
Frozen pudding (carbohydrates of raw farina, 430.2 grams or 61.02 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,622.4	*Grams.* 130.4	*Grams.* 224.6	*Grams.* 705.0	*Grams.* 17.6
Fruit	1,013.0	880.3	8.1	2.0	117.5	5.1
Sugar						
Total food consumed	3,713.0	2,502.7	138.5	226.6	822.5	22.7
Feces	60.0		17.8	14.9	18.3	8.9
Amount utilized			120.7	211.7	804.2	13.8
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			87.2	93.4	97.8	60.8
Estimated digestibility of carbohydrates of raw farina alone					99.8	

[3] Ztschr. Biol., 30 (1894), p. 350.

[4] Proc. Nat. Acad. Sci. 5 (1919), No. 11, pp. 514–517.

TABLE 7.—*Digestion experiments with raw farina in a simple mixed diet*—Continued.

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1191, subject R. J.:						
Frozen pudding (carbohydrates of raw farina, 418.2 grams or 61.02 per cent of total carbohydrate)	*Grams.* 2,625.0	*Grams.* 1,577.4	*Grams.* 126.8	*Grams.* 218.4	*Grams.* 685.4	*Grams.* 17.1
Fruit	855.0	743.0	6.8	1.7	99.2	4.3
Sugar	9.0	.....	.....	.....	9.0	.....
Total food consumed	3,489.0	2,320.4	133.6	220.1	793.6	21.4
Feces	39.0	.....	10.7	10.8	11.8	5.7
Amount utilized	.....	.....	122.9	209.3	781.8	15.7
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	92.0	95.1	98.5	73.4
Estimated digestibility of carbohydrates of raw farina alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1192, subject C. M.:						
Frozen pudding (carbohydrates of raw farina, 430.2 grams or 61.02 per cent of total carbohydrate)	*Grams.* 2,700.0	*Grams.* 1,622.4	*Grams.* 130.4	*Grams.* 224.6	*Grams.* 705.0	*Grams.* 17.6
Fruit	927.0	805.6	7.4	1.9	107.5	4.6
Sugar	.....	.....	.....	.....	.....	.....
Total food consumed	3,627.0	2,428.0	137.8	226.5	812.5	22.2
Feces	22.0	.....	6.5	4.7	7.2	3.6
Amount utilized	.....	.....	131.3	221.8	805.3	18.6
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	95.3	97.9	99.1	83.8
Estimated digestibility of carbohydrates of raw farina alone	.....	.....	.....	.....	100.0	.....
Experiment No. 1193, subject R. L. P.:						
Frozen pudding (carbohydrates of raw farina, 414.3 grams or 61.02 per cent of total carbohydrate)	*Grams.* 2,600.0	*Grams.* 1,562.3	*Grams.* 125.6	*Grams.* 216.3	*Grams.* 678.9	*Grams.* 16.9
Fruit	965.0	838.6	7.7	1.9	111.9	4.8
Sugar	93.0	.....	.....	.....	93.0	.....
Total food consumed	3,658.0	2,400.9	133.3	218.2	883.8	21.7
Feces	12.0	.....	4.3	2.8	3.3	1.6
Amount utilized	.....	.....	129.0	215.4	880.5	20.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	96.8	98.7	99.6	92.6
Estimated digestibility of carbohydrates of raw farina alone	.....	.....	.....	.....	100.0	.....
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,207.2	804.3	45.3	74.3	276.0	7.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration	.....	.....	92.8	96.3	98.8	77.7
Average digestibility of carbohydrates of raw farina alone	.....	.....	.....	.....	100.0	.....

EXPERIMENTS WITH RAW WHITE CORN MEAL.

Three experiments were conducted with raw white corn meal. Analysis showed the composition of the corn meal to be: Water, 10.54 per cent; protein, 8.88 per cent; fat, 4.24 per cent; carbohydrate, 75.04 per cent, including 1.67 per cent crude fiber; and ash, 1.3 per cent.

The entire diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 34 grams; fat, 68 grams; carbohydrate, 242 grams; energy, 1,715 calories. The average amount of corn meal eaten per woman per day was 158 grams and the carbohydrate supplied by the corn meal was 119 grams.

The average coefficient of digestibility of the carbohydrate of the corn meal alone was 98.6 per cent. If allowance is made for 47 per cent undigested crude fiber, the resulting coefficient of digestibility is 99.6 per cent. Microscopic examination showed absence of starch

grains in the feces. The coefficients of digestibility of the protein and fat of the entire diet were 86.3 per cent and 95.6 per cent, respectively.

TABLE 8.—*Digestion experiments with raw white corn meal in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1186, subject A. T. M.:						
Frozen pudding (carbohydrates of raw white corn meal, 362.2 grams or 61.26 per cent of total carbohydrate)	*Grams.* 2,370.0	*Grams.* 1,460.9	*Grams.* 94.1	*Grams.* 205.0	*Grams.* 591.3	*Grams.* 18.7
Fruit	1,028.0	893.3	8.2	2.1	119.2	5.1
Sugar						
Total food consumed	3,398.0	2,354.2	102.3	207.1	710.5	23.8
Feces	55.0		13.7	10.4	22.6	8.3
Amount utilized			88.6	196.7	687.9	15.5
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			86.6	95.0	96.8	65.1
Estimated digestibility of carbohydrates of raw white corn meal alone					98.3	
Experiment No. 1187, subject R. J.:						
Frozen pudding (carbohydrates of raw white corn meal, 351.3 grams or 61.26 per cent of total carbohydrate)	*Grams.* 2,298.0	*Grams.* 1,416.5	*Grams.* 91.2	*Grams.* 198.8	*Grams.* 573.4	*Grams.* 18.2
Fruit	1,254.0	1,089.7	10.0	2.5	145.5	6.3
Sugar	20.0				20.0	
Total food consumed	3,572.0	2,506.2	101.2	201.3	738.9	24.5
Feces	52.0		12.5	7.9	24.3	7.2
Amount utilized			88.7	193.4	714.6	17.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			87.6	96.1	96.7	70.6
Estimated digestibility of carbohydrates of raw white corn meal alone					98.6	
Experiment No. 1188, subject C. M.:						
Frozen pudding (carbohydrates of raw white corn meal, 355.1 grams or 61.26 per cent of total carbohydrate)	*Grams.* 2,323.0	*Grams.* 1,431.9	*Grams.* 92.2	*Grams.* 200.9	*Grams.* 579.6	*Grams.* 18.4
Fruit	1,247.0	1,083.6	10.0	2.5	144.7	6.2
Sugar						
Total food consumed	3,570.0	2,515.5	102.2	203.4	724.3	24.6
Feces	57.0		15.5	8.9	23.2	9.4
Amount utilized			86.7	194.5	701.1	15.2
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration			84.8	95.6	96.8	61.8
Estimated digestibility of carbohydrates of raw white corn meal alone					98.8	
Average food consumed per subject per day	*Grams.* 1,171.1	*Grams.* 819.5	*Grams.* 34.0	*Grams.* 68.0	*Grams.* 241.5	*Grams.* 8.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration			86.3	95.6	96.8	65.8
Average digestibility of carbohydrates of raw white corn meal alone					98.6	

EXPERIMENTS WITH RAW WAXY MAIZE MEAL.

Three experiments were conducted with raw waxy maize meal. The material was obtained from G. N. Collins, Bureau of Plant Industry, who had discovered this previously unknown type in samples of maize sent from China in 1908.[5] The characteristic of this grain is the endosperm which when cut shows a dull, smooth surface like that of hard wax. There is only a trace of starch in the scutellum. The endosperm contains a considerable amount of material having granules similar in appearance to those of corn-

[5] U. S. Dept. Agr., Bur. Plant Indus. Bul. 161 (1909).

starch. This material when crushed and treated with water and stained with a diluted solution of iodin in potassium iodid gives the reddish brown or violet color said to be characteristic of erythrodextrin.

The waxy maize used in the digestibility experiments was ground at the Bureau of Chemistry; the kernels were more dry than is usual in milling corn, and as a result only 3.2 per cent of the total grain was removed as bran. Chemical analysis shows the general food value of waxy maize meal to be similar to that of the white corn meal.

TABLE 9.—*Chemical composition of waxy maize meal and white corn meal.*

	Moisture.	Protein.	Fat.	Carbohydrate.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Waxy maize meal	9.88	10.63	6.17	71.52	1.80
White corn meal	10.54	8.88	4.24	75.04	1.30

The carbohydrate of the waxy maize meal included 1.83 per cent crude fiber, and that of white corn meal 1.67 per cent. As indicated by these analyses, there is no great difference in the amounts of protein, fat, carbohydrate, and ash furnished by these two types of maize.

The ground raw waxy maize was made into frozen pudding and served in the usual way. The diet furnished the following average amounts of nutrients and energy per woman per day: Protein, 39 grams; fat, 78 grams; carbohydrate, 279 grams; energy, 1,970 calories. The average amount of raw waxy maize eaten per woman per day was 184 grams, and the average amount of carbohydrate from the maize alone was 132 grams.

The average coefficient of digestibility for the carbohydrate of the maize alone was 97.3 per cent. If allowance is made for 47 per cent undigested crude fiber, the average coefficient becomes 98.5 per cent. The coefficients of digestibility of the protein and fat of the entire diet were respectively 86.9 and 96.7 per cent. Microscopic analysis of the feces gave no evidence of undigested starch or dextrinlike substance. The digestibility of waxy maize meal as shown by these experiments is very slightly lower than that of white corn meal, but the difference is too small to seem of practical significance. The subjects enjoyed the flavor and texture of the pudding made with waxy maize meal.

TABLE 10.—*Digestion experiments with raw waxy maize meal in a simple mixed diet.*

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1204, subject A. T. M.:						
Frozen pudding (raw waxy maize meal, 408.4 grams or 60.11 per cent of total carbohydrate)	*Grams.* 2,600.0	*Grams.* 1,543.9	*Grams.* 114.1	*Grams.* 238.9	*Grams.* 679.4	*Grams.* 23.7
Fruit	806.0	700.4	6.4	1.6	93.5	4.0
Sugar	112.0	.....	.....	.....	112.0	.....
Total food consumed	3,518.0	2,244.3	120.5	240.5	884.9	27.7
Feces	58.0	.....	14.2	8.8	26.4	8.6
Amount utilized	.....	.....	106.3	231.7	858.5	19.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	88.2	96.3	97.0	69.0
Estimated digestibility of carbohydrates of raw waxy maize meal alone	.....	.....	.....	.....	97.7	.....

TABLE 10.—*Digestion experiments with raw waxy maize meal in a simple mixed diet*—Con.

Experiment, subject, and diet.	Weight of food.	Constituents of foods.				
		Water.	Protein.	Fat.	Carbohydrate.	Ash.
Experiment No. 1205, subject C. M.:						
Frozen pudding (raw waxy maize meal, 398.2 grams or 60.11 per cent of total carbohydrate)	*Grams.* 2,535.0	*Grams.* 1,505.3	*Grams.* 111.3	*Grams.* 233.0	*Grams.* 662.4	*Grams.* 23.1
Fruit	1,056.0	917.7	8.4	2.1	122.5	5.3
Sugar	17.0	.....	.....	.....	17.0	.....
Total food consumed	3,608.0	2,423.0	119.7	235.1	801.9	28.4
Feces	52.0	.....	13.7	5.2	25.8	7.3
Amount utilized	.....	.....	106.0	229.9	776.1	21.1
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	88.6	97.8	96.8	74.3
Estimated digestibility of carbohydrates of raw waxy maize meal alone	.....	.....	.....	.....	98.0	.....
Experiment No. 1206, subject E. R.:						
Frozen pudding (raw waxy maize meal, 376 grams or 60.11 per cent of total carbohydrate)	2,400.0	1,425.1	105.4	220.6	627.1	21.8
Fruit	1,158.0	1,006.3	9.3	2.3	134.3	5.8
Sugar	63.0	.....	.....	.....	63.0	.....
Total food consumed	3,621.0	2,431.4	114.7	222.9	824.4	27.6
Feces	71.0	.....	18.6	8.7	34.0	9.8
Amount utilized	.....	.....	96.1	214.2	790.4	17.8
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Digestibility of entire ration	.....	.....	83.8	96.1	95.9	64.5
Estimated digestibility of carbohydrates of raw waxy maize meal alone	.....	.....	.....	.....	96.2	.....
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Average food consumed per subject per day	1,194.1	788.7	39.4	77.6	279.0	9.3
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Average digestibility of entire ration	.....	.....	86.9	96.7	96.6	69.3
Average digestibility of carbohydrates of raw waxy maize meal alone	.....	.....	.....	.....	97.3	.....

SUMMARY.

In digestion experiments with women it was shown that pure raw starch from corn, wheat, and rice flours was completely digested.

Experiments on raw potato starch gave coefficients of digestibility varying from 100 per cent to 49 per cent. The average value was 81 per cent.

Experiments with raw patent flour and raw farina, wheat products containing practically no bran, in all cases gave a coefficient of digestibility of 100 per cent for the starch.

The average digestibility of the carbohydrate in raw graham flour was 97 per cent. The lower coefficient as compared with that of patent flour is doubtless due to the high bran content of graham flour.

The carbohydrate in raw corn meal was in round numbers 99 per cent digested.

The average coefficients of digestibility of the raw starches as determined in these experiments with women are practically the same as those determined in previous experiments with men as subjects.

The carbohydrate characteristic of the endosperm of raw waxy maize, a substance reacting red with iodin, gave a coefficient of digestibility of, in round numbers, 97 per cent and is apparently as digestible as the starch in raw corn meal.

An interesting point in connection with several of the tests is that high coefficients of digestibility were obtained in spite of the fact that the subjects experienced general nervousness at the beginning of the experiments and were subject to occasional headache or other slight bodily discomfort at times during the experiment.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

January 21, 1924.

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